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The effectiveness of natural and gonadotropin stimulation of young gilts

Efektywność stymulacji naturalnej i gonadotropinowej młodych loszek

Jan DYBAŁA*, Wojciech KAPELAŃSKI, Joanna WIŚNIEWSKA and Aleksandra CEBULSKA

UTP University of Science and Technology in Bydgoszcz, Department of Pig Breeding and Horses, ul. Mazowiecka 28, 85-084 Bydgoszcz, *correspondence: dybala@utp.edu.pl

Abstract

The aim of the study was to compare the effectiveness of stimulation of gilts puberty by natural method and with gonadotropins. The results of reproduction parameters of gilts were also compared. Gilts were also supported by diet with easilly assimilated carbohydrates. The study was carried out on the group of 80 gilts which were divided into 2 groups (A and B) according to the method of inducing puberty: by using mature boar or gonadotropins eCG and hCG. In each group were isolated two subgroups in which gilts were mated in first or second estrus (A_1, A_2 and B_1, B_2). The first estrus occured earlier in gilts induced naturally. More numerous litters were obtained from gilts mated in the second estrus independently of method of puberty stimulation. The highest effectiveness of mating was obtained in gilts induced by gonadotropins in second estrus and the lowest also in gilts stimulated by gonadotropins but mated in first estrus. More piglets for 21st day were reared by gilts mated in second estrus independently on puberty induction method.

Keywords: boar presence, estrus, gilts, gonadotropins, puberty

Streszczenie

Celem pracy było porównanie efektywności stymulacji dojrzałości płciowej loszek pobudzanych dietą wzbogaconą łatwo przyswajalnymi węglowodanami metodą naturalną i gonadotropinową oraz porównanie wyników rozrodu tych zwierząt. Badanie przeprowadzono na grupie 80 loszek, które podzielono na 2 grupy (A i B) w zależności od sposobu indukowania dojrzałości płciowej: dojrzałym knurem lub gonadotropinami eCG i hCG. W każdej grupie wyodrębniono dwie podgrupy(A_1, A_2 i B_1, B_2), gdzie loszki kryto w pierwszej lub drugiej rui. Pierwszą ruję wcześniej wykazywały loszki indukowane naturalnie. Liczniejsze mioty rodziły loszki niezależnie

od metody indukowania dojrzałości płciowej, kryte w drugiej rui. Największą skuteczność krycia uzyskano u loszek indukowanych gonadotropinami w drugiej rui, a najmniejszą również indukowanych gonadotropinami, ale krytych w pierwszej rui. Więcej prosiąt do 21. dnia odchowały loszki kryte w drugiej rui, niezależnie od metody indukowania dojrzałości płciowej.

Słowa kluczowe: dojrzałość płciowa, gonadotropiny, knur, loszki, ruja

Streszczenie szczegółowe

Przeprowadzone doświadczenie miało na celu zbadanie efektywności stymulacji naturalnej i gonadotropinowej u loszek. Grupę 80 loszek mieszańcowych F_1 (wbp x pbz) podzielono na dwie grupy A i B, po 40 osobników każda. Każdą z nich podzielono na kolejne dwie grupy po 20 osobników: A_1 i A_2 oraz B_1 i B_2. Loszki z grup A_1 i B_1 kryto w pierwszej rui, natomiast loszki z grup A_2 i B_2 w drugiej rui. Wszystkie loszki od 142 dnia życia, przez 21 dni żywiono wspomagającą dietą, tzw. insulinogenną wzbogaconą łatwo przyswajalnymi węglowodanami w postaci glukozy i śruty kukurydzianej. Dieta ta powoduje utrzymywanie się podwyższonego poziomu insuliny, hormonu metabolicznego, który między innymi zwiększa receptywność układu rozrodczego na gonadotropiny. Wszystkie zwierzęta zakwalifikowane do doświadczenia były bardzo wyrównane pod względem wieku i masy ciała. Od 150 dnia życia loszek rozpoczęto stymulację naturalną w grupie A, gdzie knura wprowadzano do kojca z loszkami 2 x dziennie na ok. 20 minut. Loszkom z grupy B zainiekowano domięśniowo 750 IU eCG i po 72 godz. 500 IU hCG. Po kolejnych 16 dniach zwierzętom z grupy B_2 podano te same hormony, jednak w formie preparatu zawierającego ich kombinację w ilości odpowiednio 400 i 200 IU.
Pierwsza ruja u loszek z grupy A_1 wystąpiła w wieku 171,55 ± 9,94 dni, gdy uzyskały one średnio 94,25 ± 5,73 kg masy ciała. Natomiast loszki z grupy B_1 pierwszą ruję wykazały w wieku 193,38 ± 9,25 dni i przy masie ciała 100,13 ± 5,11 kg.
W odniesieniu do obu wartości różnice okazały się wysoko istotne statystycznie ($P \leq 0,01$). Drugą ruję loszki z grupy A_2 wykazały w wieku 204,28 ± 8,09 dni, a z grupy B_2 w wieku 212,35 ± 10,13 dni - różnica istotna statystycznie ($P \leq 0,05$). Masa ciała w obu grupach była bardzo zbliżona i wynosiła odpowiednio 110,75 ± 3,61 kg i 110,94 ± 4,92 kg. Kolejnym analizowanym parametrem była skuteczność krycia. Największą skuteczność krycia wynoszącą 100% odnotowano w grupie B_2 a najmniejszą wynoszącą 75% w grupie B_1 ($P \leq 0,05$). Natomiast w grupach loszek indukowanych naturalnie skuteczność krycia była zbliżona i wynosiła w grupie A_1 88,90% a w grupie A_2 90,00%. Liczniejsze mioty rodziły lochy kryte w drugiej rui, zarówno stymulowane naturalnie jak i gonadotropinowo (A_2 10,15 ± 1,27; B_2 9,94 ± 3,30). Najmniej liczne mioty urodziły loszki indukowane gonadotropinami i kryte w pierwszej rui (B_1) 8,56 ± 1,31. Pomiędzy grupami A_2 i B_2 a B_1 wykazano różnicę istotną statystycznie ($P \leq 0,05$). Jednym z najważniejszych parametrów charakteryzujących użytkowość rozpłodową loch jest liczba odchowanych prosiąt w miocie. Najwięcej prosiąt 9,80 ± 1,05 odchowały lochy z grupy A_2, natomiast mniej z grup loch krytych w pierwszej rui (A_1 8,56 ± 1,04 i B_1 8,25 ± 1,04), różnica między grupą A_2 a grupami A_1 i B_1 była istotna statystycznie ($P \leq 0,05$).

Pierwszą ruję wykazały loszki, u których dojrzałość płciową indukowano naturalnie. Największą skuteczność krycia uzyskano u loszek indukowanych gonadotropinami, krytych w drugiej rui. Najmniejszą natomiast indukowanych również gonadotropinami, ale krytych w pierwszej rui. Mniej liczne mioty rodziły loszki kryte w pierwszej rui niezależnie od metody indukowania dojrzałości płciowej. Do 21 dnia więcej prosiąt odchowały loszki kryte w drugiej rui, również niezależnie od metody indukowania dojrzałości płciowej.

Introduction

Nowadays the used pigs are the rapidly growing animals and of late somatic. These two important characteristics are genetically conditioned, but their level is also affected by the environmental factors. The effect of rapid growth makes the gilts at a relatively young age reach a high body weight, which is considered as one of the determinants of reproductive maturity. In turn, late somatic maturing predetermines to some extent the period of the first estrus as a symptom of sexual maturity. There is therefore a discrepancy between the growth of animals and their sexual maturity. Mating the gilts of high weight (> 130 kg) as well as over the age of 8 months is disadvantageous for economic reasons. For this reason, observed a growing interest in early mating of gilts, which as it turns out gives the possibility of full use of their reproductive capacity. An important justification for the early use of breeding gilts is the research conducted by Kapelańskiego et al. (2001), which showed that gilts gained high production, giving birth to piglets for the first time at the age of about 300 days. This issue was dealt with also by other authors who obtained similar results (Lecyk, 1983; Iniarska et al., 1991; Kapelańska et al. 1997).

There is therefore a problem of choosing the method of the effective way to induce early sexual maturity of gilts and the impact on the satisfactory outcome in the reproduction of these animals. It is believed that one of the most effective ways of influencing the onset of sexual maturity of gilts is the contact with the boar. Patterson et al. (2002) have demonstrated that exposure to a boar from the age of 135 days resulted in about 75% estrus sows in the occurrence of estrus within 30 days. In studies of Martin Rillo et al. (2001), was obtained 78% efficiency of mating of gilts stimulated by the presence of the boar and inseminated at the age of 175 ± 5 days of life.

Another widely known method for inducing sexual maturation, and even the synchronization of estrus in gilts is to use the exogenous gonadotropins, mainly the hCG and eCG at doses of 750-1500 IU and 500-1000 IU at an interval of 72 hours (Karalus et al., 1990; Wiesak et al., 1990). However, as a result of the hormonal induction of sexual maturity often observed a high percentage of ineffective mating or extending the time to the next spontaneous estrus. To avoid this, a second re-stimulation of estrus is conducted (Kapelański et al., 2003). The effect of hCG and eCG were tested not only for the induction of sexual maturity in gilts and the synchronization of estrus, but also the influence of these hormones on the function of the corpora lutea (CL) and the fallopian tubes. Szymańska et al. (2014) indicate that in gilts the injection of PGF2α/eCG/hCG does not impair the function of the CL, which are the key components of the enzyme and the receptor for synthesis of P4. However, there was a lower concentration of P4 in the serum of animals

synchronized, which may reflect some irregularities in the metabolism or secretion of P4. While Malysz-Cymborska and Andronowska (2015) report that the use of hormones routinely used to induce ovulation and superovulation affects the synthesis of the PGI2 and the IP, which may adversely affect and cause abnormal expression of the PGI2 and IP in the fallopian tube of pigs during the after estrus period and consequently affect the reproductive performance of animals.

To increase the effectiveness of the hormonal stimulation of estrus in sexually immature gilts, you can apply the so-called "insulinogenic" diet. The research which was conducted by Kapelański et al. (2002; 2003) have shown that the diet given for 25 days to the sexually immature gilts, increased the effectiveness of the hormonal stimulation of the estrus by eCG and hCG and increased the receptivity of the reproductive system to these gonadotropin, which has improved in a number of indicators of usability of the breeding gilts. Also, other studies have shown that the administration of a diet supplement containing corn starch and 60 g of glucose/kg feed for gilts at the age of 140-150 days, significantly increased the postprandial insulin secretion, increased the weight of the ovaries, uterus, and the number of anovulatory follicles (Zięcik et al., 2002a; Zięcik et al., 2002b).

The aim of this study was to compare the effectiveness of the natural (boar) and gonadotropin (eCG and hCG) stimulation in sexually immature gilts that received a diet supplemented with easily digestible carbohydrates and the comparison of their breeding results.

Materials and methods

The study was conducted on 80 gilts of the F_1cross-breed (PLW x PL). Animals were divided into two groups: A, B (40 subjects). Each group was kept in a separate room, due to the different method of inducing estrus (natural or gonadotropin). All gilts from 142 days of age, for 21 days received the so called insulinogenic diet (feeding stimulus). The mixture was enriched with soybean, corn (18% share), and glucose (6% share). One kg of this mixture contained 12.94 MJ and 198.00 g of protein. Each of these groups was also divided into two subgroups: A_1, A_2, B_1, B_2 (20 gilts each) where the animals were mated during the I or II estrus. The experimental diagram is shown in Table 1.

Table 1. Scheme of experiment

Tabela 1. Schemat doświadczenia

Group of gilts			
A (40 gilts) Stimulation of puberty by the natural method - the presence of boar		B (40 gilts) Stimulation of buberty by using hormones (eCG + hCG)	
A_1 (20 gilts) Mating in I estrus	A_2 (20 gilts) Mating in II estrus	B_1 (20 gilts) Mating in I estrus	B_2 (20 gilts) Mating in II estrus

All the animals were very balanced in terms of age and body weight. At the age of 134 days gilts in group A weighed 65.86 ± 7.00 kg, and Group B 65.45 ± 5.58 kg. The administration of the diet started when the gilts reached 142.43 ± 2.25 days (group A) and 142.40 ± 2.24 days (group B). Since 150 day of life, the gilts in group A began natural stimulation, where the boar was introduced into the pen to gilts 2 times a day for about 20 minutes. Gilts in group B treated with 750 IU eCG and after 72 hours with 500 IU hCG. After a further 16 days, the animals of group B_2 were given the same hormones; however, in the form of a preparation containing a combination in the amount of 400 and 200 IU.

The obtained results were statistically described, the arithmetic mean (x) and standard deviation (S) was also calculated. The significance of differences between the groups was calculated using the Duncan's test for independent samples. The calculations were made using the computer program - Statistica version 9.1.

Results and discussion

Table 2 shows the results of the reproductive performance of sows undergoing the induction of sexual maturity in a natural or gonadotropin way. It was found that I estrus developed the fastest in a group of gilts stimulated with a boar (A_1) at an average age of 171.55 ± 9.94 days, while the latest in the group induced with gonadotropins (B_1), because at the age of 193.38 ± 9.25 days. In the other groups (A_2 and B_2) the gilts had estrus in a very similar period 181.65 ± 9.24 and 181.44 ± 6.93 days respectively - the difference was not statistically significant. Among other groups, the difference in the date of the first estrus proved to be highly statistically significant. The results show that after the end of the insulinogenic diet and the start of the stimulation gilts with a boar, the estrus appeared the fastest, because after about 8 days, in gilts of group A_1, and the latest in group B_1 in gilts stimulated with gonadotropins, because in less than 30 days.

Patterson et al. (2002) report that the stimulation of gilts with the presence of a boar can start at the age of 135 days and after 30 days about 75% of gilts showed estrus.

The lowest body weight on the day of the first estrus (94.25 ± 5.73 kg) also showed the youngest gilts of the group A_1 and the highest (100.13 ± 5.11 kg) the oldest gilts of the group B_1 - a highly statistically significant difference ($P \leq 0.01$).

The gilts from groups A_2 and B_2 were mated in the second estrus, which occurred in 204.28 ± 8.09 day and 212.35 ± 10.13 days of age respectively. Earlier II estrus, similarly as I one, had the gilts stimulated with a boar - a statistically significant difference (P≤0.05). Body weight in both groups of gilts was very similar, and amounted to 110.75 ± 3.61 kg (A_2) and 110.94 ± 4.92 kg (B_2).

An important indicator of the efficiency of breeding pigs is the efficacy of their mating (Table 2). The best, because 100% efficiency was obtained in the group of gilts stimulated twice with gonadotropins and covered in the second estrus (B_2). In contrast, about 25% weaker results were recorded in the group of gilts also stimulated with gonadotropins, but mated in the I estrus (B_1). For this feature between the two groups demonstrated a statistically significant difference (P≤0.05).

The obtained results confirm the studies of other authors (Kapelański et al. 2003), which show that as a result of the hormonal stimulation of the I estrus can cause an ineffective mating, or extending the period to the next spontaneous estrus. There is therefore a need to stimulate the second estrus, which shortens the waiting time for its occurrence.

Similar efficacy of mating was obtained in groups of gilts stimulated with a boar, mated both in I and II estrus (88.90% and 90.00% respectively).

Martin Rillo et al. (2001) in their study achieved 78% efficiency of mating in gilts stimulated by the presence of a boar and inseminated at the age of 175 ± 5 days of life.

The length of pregnancy in all the analyzed groups of gilts was characteristic for these species and ranged from 113.65 ± 1.35 days in the group A_2 to 114.81 ± 1.76 days in group B_1.

The number of live piglets born per litter was at a satisfactory level. Numerous litters were obtained from gilts covered in the second estrus, regardless of the method of stimulation and their sexual maturity, i.e. in the group A_2 - 10.15 ± 1.27 of piglets and in the group B_2 - 9.94 ± 3.30 of piglets. The least numerous litters were born from gilts covered in the I estrus stimulated with gonadotropins (group B_1: 8.56 ± 1.31). Between the group B_1, and A_2 and B_2 demonstrated a statistically significant difference (P≤0.05). The number of litters also influenced their weight. The most numerous litters from groups A_2 and B_2 had the highest weight (14.20 ± 1.73 and 14.15 ± 4.88 kg), while less numerous litters were born by sows from the group A_1 and were characterized by average lower weight (11.69 ± 3 , 13 kg). The difference in the weight of litters between the listed groups is statistically significant (P≤0.05).

The obtained results can be considered as well, especially that the assessed animals were relatively young. Kasprzyk and Babicz (2007) reported that an analysis of the reproductive performance of sows in the production farm showed that the animals in the first litter gave birth to on average 8.16 of piglets. Better results in their study received Mucha et al. (2011), where the sows in the first litter born on average 11.98 ± 0.95 of piglets. It should be noted; however, that these animals were mated at the age of 210.81 ± 14.50 days, so they were much older than the ones in this analyzed experiment.

In pigs it is normal to give birth to a small percentage of dead fetuses. A limit which does not arouse concern of manufacturers is on average about 0.5 of dead piglet per

litter. This characteristic was also evaluated in groups of sows submitted to early stimulation of sexual maturity. The results are at the average level. The smallest number of dead piglets (0.15 ± 0.36) in a litter born sows from the group A_2, while the highest (0.56 ± 0.72) - sows from group B_1 - a statistically significant difference. In the other two groups (A_1 and B_2) were born 0.44 ± 0.51 and 0.35 ± 0.61 of dead piglets were born per litter respectively.

Sows from all the analyzed groups reared piglets well and despite their young age proved to be caring mothers. This result may also demonstrate ensuring the proper animal welfare, quality of maintenance and care. The highest number of piglets were reared by the sows from the group A_2 (natural stimulation, mating in II estrus) 9.80 ± 1.05. This is probably also the largest number of piglets born per litter. Losses of piglets in this group averaged 0.35 of piglets (10.15 born, reared 9.80), which is 3.45%. The smallest number of piglets reared the sows from the group B_1 (8.25 ± 1.04), where litters at birth were also the least numerous. Losses in this group were on average 0.31 of a piglet, which is 3.62% (8.56 to 8.25). The sows from the group A_1 average litter 8.56 ± 1.04 of piglets. Losses in relation to the number of born piglets in this group averaged only 0.27 of a piglet, which is 3.05%. In the group B_2 sows reared an average of 9.41 ± 2.74 piglets - losses in relation to the number of born piglets amounted to 5.33%. Statistically significant differences with respect to these features were noticed between the group A_2, and the groups A_1 and B_1.

Kasprzyk and Babicz (2007) in their study showed that sows in the first litter reared till 21st day an average of 7.86 piglets, and the losses in relation to the number of born piglets amounted to 3.79%.

Piglets during rearing showed different growth rates, which resulted in the weight of litters in the weaning day. Higher weight characterized litters of sows mated in II estrus, regardless of their stimulation (A_2: 57.75 ± 5.45 kg, B_2: 54.97 ± 10.54 kg). In contrast, lower weight on weaning litters of sows were received from groups A_1 and B_1 - 50.47 ± 8.37 and 47.25 ± 6.59 kg respectively. The difference between groups A_2 and B_2, and A_1 and B_1 is highly statistically significant ($P \leq 0.01$). The results may indicate that the larger gains achieved piglets which were born from older sows (mated in II estrus). A statistically significant difference has been shown also in favour of the sows mated in II estrus but stimulated naturally.

Table 2. The values of selected traits of reproductive performance of gilts mated in the Ist and IInd estrus, stimulated naturally or with gonadotropins

Tabela 2. Wartości wybranych cech użytkowości rozpłodowej loszek krytych w I i II rui stymulowanych naturalnie lub gonadotropinami

Trait	Group of gilts			
	A (natural stimulation)		B (gonadotropins stimulation)	
	A_1 mating in I estrus	A_2 mating in II estrus	B_1 mating in I estrus	B_2 mating in II estrus
Age at I estrus (days)	171.55^{C} ± 9.94	181.65^{B} ± 9.24	193.38^{A} ± 9.25	181.44^{B} ± 6.93
Body weight of gilts at I estrus (kg)	94.25^{B} ± 5.73	-	100.13^{A} ± 5.11	-
Age at II estrus (days)	-	204.28^{b} ± 8.09	-	212.35^{a} ± 10.13
Body weight of gilts at II estrus (kg)	-	110.75 ± 3.61	-	110.94 ± 4.92
Mating effectiveness (%)	88.90	90.00	75.00^{b}	100.00^{a}
Pregnancy length (days)	114.61 ± 1.65	113.65 ± 1.35	114.81±1.76	114.53 ± 1.23
Number of live born piglets per litter (n)	8.83 ± 0.99	10.15^{a} ± 1.27	8.56^{b} ± 1.31	9.94^{a} ± 3.30
Number of dead piglets born per litter (n)	0.44 ± 0.51	0.15^{b} ± 0.36	0.56^{a} ± 0.72	0.35 ± 0.61
Weight of litter at day of birth (kg)	11.69^{b} ± 3.13	14.20^{a} ± 1.73	12.28 ± 2.09	14.15^{a} ± 4.88
Number of piglets at 21st day (n)	8.56^{b} ± 1.04	9.80^{a} ± 1.05	8.25^{b} ± 1.04	9.41 ± 2.74
Weight of litter at 21st day (kg)	50.47^{AB} ± 8.37	57.75^{aA} ± 5.45	47.25^{B} ± 6.59	54.97^{bA} ± 10.54

A, B - statistically significant differences at P≤0.01
a, b - statistically significant differences at P≤0.05

Wartości oznaczone różnymi literami różnią się istotnie: A, B przy P≤0,01; a, b przy P≤0,05

Conclusions

The first estrus was earlier observed in gilts, whose sexual maturity was induced naturally. The number of piglets born per litter was lower in gilts mated in the first estrus, induced both in the natural and gonadotropin ways. The greatest effectiveness of covering was observed in gilts induced with the use of gonadotropins, covered in the second heat. While the smallest is also induced by gonadotropins, but covered in the first estrus. More piglets till 21st day were reared by gilts mated in the second estrus, regardless of the method of inducing their sexual maturity.

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